

THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY—COLUMBIA MEETING.

THE second annual meeting of the Society for Plant Morphology and Physiology was held, along with the American Society of Naturalists and the affiliated societies, at Columbia University, Tuesday to Friday, December 27 to 30, 1898. On Tuesday evening a reception was tendered to the members of the society and visiting botanists by the Torrey Botanical Club, in the rooms of the Department of Botany of the University. The society joined with the other societies in the annual discussion on Thursday afternoon (upon advances in methods of teaching), and in the annual dinner of the affiliated societies on Thursday evening. On Friday morning an excursion was made to the New York Botanical Garden, where the grounds and buildings were shown by the director, Dr. N. L. Britton. At the business sessions of the society the following officers were elected for the ensuing year: president, J. M. Macfarlane; vice presidents, G. F. Atkinson and D. P. Penhallow; secretary, W. F. Ganong. The following new members were elected: F. C. Stewart, C. O. Townsend, F. C. Newcombe, B. D. Halsted, J. B. Pollock, D. S. Johnson, L. M. Underwood, M. B. Waite. The sessions for the reading of papers were presided over by the president, Dr. W. G. Farlow. The presidential address, on "Peculiarities of the Distribution of Marine Algæ in North America," was delivered at 4:00 P.M., on Thursday. It is hoped that it will soon be published in full. The following papers were presented, the abstracts having been prepared in every case by the authors.¹

W. F. GANONG, *Secretary*.

Some peculiar morphological structures in Paulownia imperialis:
JOHN W. HARSHBERGER, University of Pennsylvania.—*Paulownia*

¹The condensation of some of these abstracts has been necessary on account of our limited space.—EDS.

imperialis, a Japanese tree of dense umbrageous habit, is interesting botanically from several standpoints. The method of branching is sympodial. The main shoot is terminated by an inflorescence, which dies back, after the seeds are discharged, to an axillary bud that prolongs the growth the next season. The flower buds, which are grouped in dichotomous cymes approaching the scorpioid form, are protected during the winter by the fleshy calyx and dense ferruginous hairs. The flowers, which expand in spring, are fully formed within the sepals. The leaves also are hirsute, and are thus protected from the full force of the sun's rays. The fruit, which discharges in midwinter the winged seeds, is provided with a fleshy cushion that contains a considerable quantity of tannin. It is possible that this tannin is a reserve product, for when the seeds are ripe and the cushion falls out, there is not a trace of tannin left. The petiole contains a large number of crystals of calcium oxalate surrounding the hard bast. The different forms of these crystals are probably due to varying conditions of metabolism in the autumn, since the forms of crystals may be made to vary by altering the conditions of crystallization.

The life-history of Leuchtenbergia principis: W. F. GANONG, Smith College.—The life-history of this most noteworthy of the Cactaceæ has hitherto been quite unknown. Seeds and young plants obtained from Mexico have enabled the author to work out the anatomical and morphological development through all stages except that from the opened flower to the ripe fruit. The paper discusses the history of our knowledge of the species, gives a full description of it, an account of its geographical distribution, its habits and ecology, its morphological composition as determined by comparative anatomy and embryology, the precise internal anatomy of the adults, and of the parts unfolding from the vegetative points and of the embryos in their unfolding from the seed to the adults. This work is intended by the author as the first of a series of life-histories of members of this family, which are expected to yield data for a better understanding both of the phylogeny of the genera and of the principles of

morphology and ecology illustrated by this highly specialized family.

Root tubercles upon spring and autumn grown legumes: B. D. HALSTED, New Jersey Agricultural College.—The ninth successive crop of wax beans upon the same plot, grown in the spring, consisted of plants whose roots were abundantly supplied with large, nearly spherical tubercles. The plants of the succeeding crop grown in the summer upon the same soil had very few tubercles. The cause of this difference was sought in the soil conditions. During the early growth of the spring plants the soil was considerably cooler than in August when the second crop was passing through the initial stages of development. There was, doubtless, also less available soil nitrogen in the comparatively cool earth of May than in the warmer ground of August. The nitrifying germs, being more active in midsummer, provided a daily supply of combined nitrogen for the young plants. The spring crop, not having this ample supply, was "nitrogen-hungry," and this furnished the proper condition for the abundant development of the tubercles. Successful inoculation of the plants with soil-extract or the pure culture of the tubercle germ, "nitragin," is dependent largely upon soil conditions and many widely varying results may thus find an explanation.

Further notes on the comparative embryology of the Rubiaceæ: F. E. LLOYD, Teachers College.—The genera studied include *Houstonia*, *Rubia*, *Sherardia*, *Vaillantia*, *Crucianella*, *Galium*, and *Asperula*.

In the hypoderm of the nucellus eight or ten macrospores develop. Many of them germinate, becoming quadrinucleate. One, sometimes two, become perfect embryo-sacs, with antipodals in all forms studied, a fact hitherto unrecognized, excepting in *Houstonia*. One of the antipodals is very large, comprising the whole lower half of the embryo sac in *Sherardia*, *Rubia*, and *Galium*. The condition in *Asperula* is not completely clear, but the writer thinks that a larger number of antipodals are present.

as in certain Compositæ. The suspensor is divided into two regions, micropylar and embryonal. The latter is composed of disk-shaped cells; the former of large cells swollen out laterally, forming absorbing organs which become applied to the endosperm. A free preparation of these structures resembles a bunch of grapes, a condition similar to that described for *Sutherlandia* by Hofmeister and Guignard. The integument becomes absorbed, the seed-covering consisting of the pericarp and a single layer of cells derived from the integument.

Inflorescences and flowers of Polygala polygama: CHARLES H. SHAW, University of Pennsylvania.—In addition to the well-known pink-purple aerial and subterranean cleistogamic flowers, an exactly intermediate type is developed on special inflorescences. These are green aerial cleistogamic flowers, borne on shoots which, though produced considerably above ground, are slightly or strongly geotropic. A detailed account of the differences between the three types was given.

Observations on the development of some monocotyledonous embryo sacs: R. E. B. MCKENNEY, University of Pennsylvania.—The development of the embryo-sac in two species of *Scilla*, *S. hyacinthoides cærulea* and *S. campanulata* was described in detail, while reference was made to *Lilium*. No centrosomes were observed during the resting condition of the nuclei or during mitosis.

The structure and relation of the crystal cells in sensitive plants: R. E. B. MCKENNEY, University of Pennsylvania.—The crystal cells in sensitive plants form a complete sheath around the bundle cylinder of stems and a half-sheath around the phloem side of leaf bundles. Each cell of the sheath contains a single large hexagonal crystal. The crystals seem to be rather insoluble silicates. The crystal cells have a very small enucleolate nucleus, no vacuoles, and no starch. The crystals make their appearance first in the cells at the distal end of the bundles of the first foliage leaf and are formed basipetally. The more sensitive plants have the crystals either more abundant or better developed than the less sensitive plants, and *vice versa*.

Structure and parasitism of Aphyllon uniflorum: AMELIA C. SMITH, University of Pennsylvania.—The most conspicuous features of this plant, as thus far worked out, are as follows: (1) Its parasitism on *Aster corymbosum*, and the degeneration attendant upon its parasitic habit, as expressed by: (*a*) absence of chlorophyll; (*b*) degeneration of leaves; (*c*) loss of root-hairs and probably of root-cap; (*d*) reduction and degeneration of the bundle system, and greater relative development of phloem than of xylem; (*e*) small size of seed, primitive embryo, and development of this embryo within mass of (probably) precocious endosperm. (2) Stomata, where present, are on the more exposed places, *i. e.*, outer surfaces of upper bract-leaves, upper part of flower-stalk, outer surfaces of calyx and corolla. (3) Starch is present in great quantities in roots, stems, leaves and carpellary tissue.

On the occurrence of tubers in the Hepaticæ: M. A. HOWE, Columbia University.—In none of the standard text-books does there appear to be any allusion to such structures. The number of known tuber-bearing species at the present time is at least eleven; of *Anthoceros* four, *Riccia* three, *Petalophyllum* two, *Fossombronia* one, and *Geothallus* one. As the Hepaticæ of the drier regions become better known this adaptation to drought will probably prove more common than now generally supposed. In the Californian *Anthoceros phymatodes*, the tuber first appears as a swelling near the apparent apex of a costa-like thickening of a thallus segment, becoming later strictly ventral through the continued onward growth of the segment, and coming at the same time to be pendent from the ventral surface through the formation of a peduncle. The body of the tuber consists of a cortex of two to four layers of nearly empty cells enclosing a mass of smaller cells so densely filled with oil-drops or nearly colorless granules that the cell-boundaries are obscure. Ashworth finds aleurone-grains and oil-drops in the interior cells of the tubers of the Australian *Anthoceros tuberosus*. The reserve food-materials in the tubers of the Californian plant seem to take the same forms. There is very little, if any, starch. In two

cases the old tubers of *Anthoceros phymatodes* have been found sending out new shoots, demonstrating that they play a part in the vegetative propagation of the plant, a function which had been only inferred in the three tuber-bearing species of *Anthoceros* previously known.

Morphology of the genus Viola: HENRY KRAEMER, Philadelphia College of Pharmacy.—The author has examined style and stigma, staminal and corolline hairs, pollen grains, and bracts in about thirty species of the genus *Viola*, chiefly found in the United States.

He distinguishes one group by its nearly globular stigma with more or less developed lip-like appendage, style with a knee-like bend, and characteristic corkscrew shaped hairs on the spurred petal. This group includes *V. heterophylla*, *V. lutea*, *V. tricolor* and its varieties.

The remaining species are subdivided into five groups, according to the length of the nectar-secreting spur of the stamen.

The influence of electricity upon plants: G. E. STONE, Massachusetts Agricultural College.—This paper contained the results of experiments based upon measurements of about 20,000 plants, and was illustrated by a dozen diagrams containing tables and growth curves showing the manner of response in plants to electrical stimuli. A brief outline of the history of electrical experiments was given, together with a discussion of the imperfections of the methods which have been employed by experimenters. Various kinds of currents were employed and data showing the relative effect of each upon germination and growth were presented. A brief résumé of some of the more important results are as follows: (1) Electricity exerts an appreciable influence upon plants. (2) The application of certain strengths of current for a short time (one minute or less) is sufficient to act as a stimulus. (3) Germination and growth are both accelerated by electricity. (4) Electrically stimulated plants do not respond immediately but possess a latent period of about twenty-five minutes, *i. e.*, about the same as that for

heliotropic and geotropic stimuli. (5) Reaction to electrical stimulation is limited to a narrow range in current intensity. The reaction is manifested either in an acceleration or retardation of metabolic activity, according to the nature or the strength of the current employed. (6) There is a minimum, optimum, cessation, and maximum stimulus. (7) The excitation produced by alternating currents is more marked than that produced by direct currents. (8) The increase of stimulus necessary to produce an equally noticeable difference of perception bears a constant ratio to the total stimulus intensity; the relationship existing between the perception and stimulus is expressed by the ratio 1 : 3 (Weber's law).

Some notes upon the germination of spores: C. O. TOWNSEND, Maryland Experiment Station.—Experiments were undertaken to determine the effect upon germination of keeping spores in distilled water under different conditions of temperature and light. Spores of Mucor, Penicillium, and other fungi were placed in test-tubes partly filled with distilled water. Some tubes were subjected to the out-door changes in temperature; others were kept at a nearly constant temperature of 18° in diffused light; others at the same temperature in the dark; and still others at 25° in the light. The spores were tested from time to time by removing a few from each set of tubes and placing them upon a mixture of gelatine and sugar in moist chambers. So long as the spores that were exposed to the natural fluctuations of temperature did not freeze they retained their ability to germinate in the usual time (12–16 hours). After freezing, however, they did not germinate. The other spores retained for at least six months their ability to germinate in the usual time. The growth of the mycelia and the ability to form new spores were not affected.

Sensitiveness of certain parasites to the acid juices of the host plants: ERWIN F. SMITH, Department of Agriculture.—The comparatively slow progress of *Pseudomonas campestris*, *P. phaseoli*, and *P. hyacinthi* when inoculated into the host plants, even in enormous

numbers, led to the belief that the restraining influence must be the acid juices of the cabbage, the bean, and the hyacinth. Experiments tend to establish this fact more definitely. All the fluids tested, hyacinth broth, cabbage juice, tomato juice, potato broth, acid beef broths, malic acid broths, etc., were titrated with caustic soda and phenolphthalein so that in each case the exact grade of acidity which retarded or inhibited growth is known definitely. This paper will soon appear in full as part of the larger work dealing with the parasitic nature and life history of Wakker's hyacinth bacterium.

Further observations on the relations of turgor to growth: CARLETON C. CURTIS, Columbia University.—Experiments were undertaken to determine the time limit for the renewal of growth after changing the concentration of the nourishing substratum, and also for testing the turgor force at the moment of renewal. Species of *Mucor*, *Penicillium*, and *Botrytis* were used. They were grown in respectively a nourishing solution, a nourishing solution with the addition of 4, 9, 14, and 20 per cent. KNO_3 . *Penicillium* in the solution with no KNO_3 had a turgor force of 7.5 (NaNO_3 being used as a test); in a 20 per cent. solution, 42.5. In changing from 0 to 20 per cent., growth ceased for from 8 to 12 hours. When it began the turgor force in the majority of cases appeared normal, *i. e.*, 42.5. In changing from 30 per cent. to 0, growth ceased for 30 to 45 minutes, when it resumed growing at the normal turgor force (7.5). So with the lesser changes, *i. e.*, from 0 to 4 per cent., recovery occurred in about one hour, turgor force normal (12); change from 4 per cent. to 0, recovery in about 15 minutes, turgor 7.5, and so on. *Botrytis* gave practically the same results. *Mucor* was much more sensitive, having a lower turgor force, and would not tolerate a change to higher than a 4 per cent. solution, but in other respects it behaved as the others. Experiments are being conducted with other salt solutions, and also upon higher plants. As regards KNO_3 it would seem that turgor is a controlling force in growth. The check due to increasing the turgor corresponds to the shock due to cutting a hypha, inhibiting growth for a time.

Symbiosis and saprophytism: D. T. MACDOUGAL, University of Minnesota.—The terms saprophyte and holosaprophyte should be applied to those forms which derive their food supply from organic products directly, without the aid of mycorrhiza, tubercles, etc. This category includes numerous bacteria, fungi, and but two seed-forming genera, *Wulfschlaegelia*, and *Cephalanthera*. The last named has been added by recent investigations of the author. The extension of the saprophytic capacity of seedlings results in the reduction of the seeds, and may also be prolonged to include the entire life history of the sporophyte.

Influence of inversions of temperature and vertical air-currents upon the distribution of plants: D. T. MACDOUGAL, University of Minnesota.—As a consequence of the rapid radiation from the soil and low conductivity of dry air, the lower layers of air are cooled much more rapidly than the upper layers. In broken regions the cooled air flows down into the valleys, giving them a lower minimum than that at the adjoining hills. The diurnal ascending currents give the hills a lower maximum than the valleys. A valley at Flagstaff, Ariz., showed a temperature 15 to 27° F. below that of an adjoining hill at night, and was 3 to 5° warmer in the day. As a consequence, the average temperature of the valley will be lower than that of the adjoining hills, and the temperature of the hills will be more equable than that of the valley, provided the difference in elevation be less than 1000^{ft}. At this and greater differences of height the disturbing factors of increased insolation, effect of altitude, and expansion and compression of the atmosphere come into play. The expansion and cooling of ascending currents of air increase their humidity, and thus give certain local ridges and rims of mesas a comparatively moist atmosphere. According to the laws of influence of temperature upon distribution, and supported by observations of the writer in the southwest, also by the results of Professor Townsend, the following conclusions are reached: (1) Inversions of temperature and resulting air-currents give minor highlands a much more equable temperature than adjoin-

ing hills and cañons. In North America such effects are most marked on the elevated plains of the southwest. (2) Inversions of temperature would result in major deflections of zonal boundaries on great level plains, and constitute a hitherto unrecognized factor in distribution. (3) Inversions of temperatures and the resulting air-currents cause abrupt deflections of the zonal boundaries corresponding to minor topographical features. Southern forms reach their extreme northernmost extension along ridges and hills. Northern forms penetrate farthest southward down valleys or cañons. (4) Ascending currents of air furnish conditions favorable to the growth of moisture-loving species along the margins of table lands bordering on valleys and cañons.

Some appliances for the elementary study of plant physiology: W. F. GANONG, Smith College.—The author pointed out that investigation is greatly aided by the wide diffusion of its results through good elementary teaching, and that the rapid introduction of plant physiology into elementary courses in botany is making a demand for simpler, less expensive and more conclusive experiments. The author then described some simple appliances developed in his physiological practicum in Smith College. These included a simple temperature stage for study of the relation of temperature to protoplasmic movement, by use of which very accurate quantitative results may be obtained; a clinostat constructed from clockwork and ample for demonstrating the principles of geotropism, etc.; a self-recording auxanometer, simple and inexpensive but yielding sufficiently accurate results for elementary work; an osmometer, using Schleicher & Schüll's diffusion shells 16^{mm} diameter in combination with burettes, giving very pronounced results; a simple new method of demonstrating the exchange of gases in respiration; an inexpensive germination box; a useful way of preparing a plant for transpiration experiments; an excellent way of graduating roots, etc., by the use of a stretched thread along which insoluble India ink is allowed to run by capillarity. A description of these appliances will be published later.

Some notes on the reproduction and development of Nereocystis: CONWAY MACMILLAN, University of Minnesota.—(Abstract not furnished.)

The formation and structure of the dissepiment in Porothelium: E. A. BURT, Middlebury College.—The author traced the development of the fructifications of *Porothelium fimbriatum* Pers. from their origin as papillæ, through the pore, to the tube stage; in the latter stage contrasting the structure of the dissepiment where the tubes are closely crowded together with its structure where they are more scattered.

Gelatin culture media: ERWIN F. SMITH, Department of Agriculture.—Dr. Smith spoke on gelatin culture media, illustrating his remarks by photographs, charts, etc. The behavior of many sensitive organisms, particularly parasites, depends entirely on how the nutrient gelatin is compounded, and consequently this should always be stated. (1) The melting point of nutrient gelatins increases as more gelatin is added. It decreases on addition of acids and alkalies and by long boiling. (2) Grape sugar or cane sugar added to nutrient gelatin frequently restrains or entirely prevents liquefaction, while at the same time it stimulates growth. For this reason gelatin should be made with beef broth free from sugar. (3) Owing to the fact that commercial gelatin contains acid salts, which are neutral or alkaline to litmus but retard the growth of many organisms, the gelatin media should first be rendered neutral to phenolphthalein, after which, if desired, it may be acidified with particular acids. A commercial gelatin of uniform character and washed free from all inhibiting acid substances is a desideratum.

Notes on the relative infrequency of fungi upon the trans-Missouri plains and the adjacent foothills of the Rocky mountain region: CHARLES E. BESSEY, University of Nebraska (Abstract presented by ERWIN F. SMITH).—In the districts named a study of fourteen years has shown the species of fungi to be numerous while the number of individuals is comparatively small, the exact opposite being true of the flowering plants, especially of her-

baceous sorts. This scarcity of individuals is especially marked in case of the higher fungi.

Different types of plant diseases due to a common Rhizoctonia: B. M. DUGGAR, Cornell University, and F. C. STEWART, New York Experiment Station.—A number of species of the sterile fungus *Rhizoctonia* have long been known as root parasites on a wide range of host plants. (1) Studies on a damping-off fungus of various seedlings have located the cause of the disease as a species of *Rhizoctonia*. (2) A fungus agreeing in structure with the latter has been the cause of a serious root-rot of sugar beets in New York during the past year, and the fungus identified with this disease seems to be undoubtedly *Rhizoctonia Betæ* Kühn. (3) An important stem-rot of carnations is also found to be due to a fungus agreeing precisely in its characters with the beet *Rhizoctonia*.

That the organism mentioned in each case is the cause of the trouble indicated has been demonstrated by experiment. Again, there is abundant experimental proof showing that the beet fungus and the carnation fungus are identical. The last named fungi also produce damping off, although not so abundantly as the fungus originally isolated from damped-off seedlings. Experiments, however, indicate that these different types of diseases are all due to the same species of *Rhizoctonia*, the specific affinities of which cannot now be given with certainty. Peculiarities in branching, and the formation of tuft-like masses of hyphæ, or of sclerotia, readily identify this fungus. Its sensitiveness to alkaline nutrient media suggests the preventive treatment.

The stem-rot diseases of the carnation: F. C. STEWART, New York Experiment Station.—Under the names "stem-rot," or "die-back," at least two distinct diseases have been confused. One is caused by *Rhizoctonia*; the other is due to a *Fusarium*, and is, perhaps, identical with Sturgis' carnation stem-rot. Both diseases are common in the field and greenhouse.

The *Fusarium* attacks chiefly the stem and larger branches,

discoloring the wood and killing the cortex, but rarely causing a soft rot. The affected plants die gradually with yellowing and drying of the foliage. The fungus rarely fruits on the outside of the stems, but more frequently in the cambium and pith of stems long dead.

The *Rhizoctonia* causes the plants to wilt suddenly by rotting the stem at or just below the surface of the soil. The cortex readily separates from the wood, the pith is attacked quite early, becoming water-soaked in appearance (corky when dry) and filled with hyphæ.